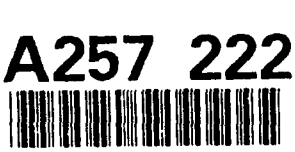

FINAL REPORT

AUGUST 1990

REPORT NO. EVT 26-90

MIL-STD-1660 TESTS ON TACTICAL EXPLOSIVE SYSTEM (TEXS)

Prepared for:

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U.S. Army Armament Research, Development
and Engineering Center
ATTN: SMCAR-AEP
Picatinny Arsenal, NJ 07806-5000

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VALIDATION ENGINEERING DIVISION
SAVANNA, ILLINOIS 61074-9639

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The U.S. Army Defense Ammunition Center and School (USADACS), Validation Engineering Division (SMCAC-DEV), was tasked by the U.S. Army Armament Research, Development and Engineering Center (ARDEC), SMCAR-AEP, Picatinny Arsenal, NJ to test the Tactical Explosive System (TEXS). This report contains the procedures, results, and recommendations from the MIL-STD-1660 tests conducted. As tested, the modified top and bottom pallet adapter assembly successfully passed MIL-STD-1660, Design Criteria for Ammunition Unit Loads.

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U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL
Validation Engineering Division
Savanna, IL 61074-9639

REPORT NO. EVT 26-90
MIL-STD-1660 TESTS
ON
TACTICAL EXPLOSIVE SYSTEM
(TEXS)

TABLE OF CONTENTS

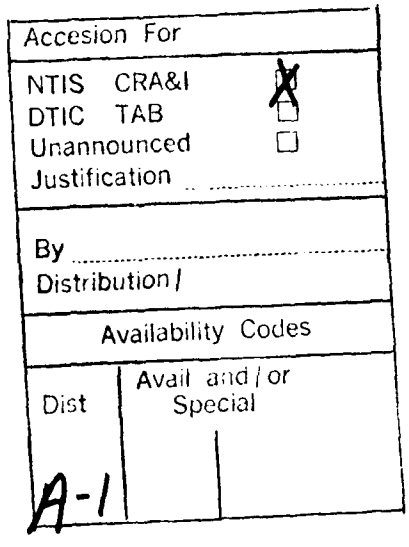
PART 1

INTRODUCTION

A. BACKGROUND. The U.S. Army Defense Ammunition Center and School (USADACS), Validation Engineering Division (SMCAC-DEV), was tasked by the U.S. Army Armament Research, Development and Engineering Center (ARDEC), SMCAR-AEP, to test the Tactical Explosive System (TEXS).

B. AUTHORITY. This test was conducted in accordance with mission responsibilities delegated by the U.S. Army Armament, Munitions and Chemical Command (AMCCOM), Rock Island, IL.

C. OBJECTIVE. The objective of this series of tests was to assess the ability of the TEXS pallet to prevent it from being damaged during transportation.



PART 2

MIL-STD-1660 TESTS ON

TACTICAL EXPLOSIVE SYSTEM (TEXS)

AUGUST 1990

TEST ATTENDEES

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PART 3

TEST PROCEDURES

The test procedures outlined in this section were extracted from MIL-STD-1660, Design Criteria for Ammunition Unit Loads, 8 April 1977. This standard identifies nine steps that a unitized load must undergo if it is considered to be acceptable. The five tests that were conducted on the test pallet are synopsized below:

1. SUPERIMPOSED LOAD TEST. The unit load shall be loaded to simulate a stack of identical unit loads stacked 16-feet-high, for a period of one hour, as specified in Method 5016, Federal Standard 101. This stacking load is simulated by subjecting the unit load to a compression of weight equal to an equivalent 16-foot stacking height. The compression load is calculated in the following manner. The unit load weight is multiplied by 192 minus the unit height in inches, then divided by the unit height in inches, then it is multiplied by a safety factor of two. The resulting number is the equivalent compressive force of a 16-foot-high load.

2. REPETITIVE SHOCK TEST. The repetitive shock test shall be conducted in accordance with Method 5019, Federal Standard 101. The test procedure is as follows: The test specimen shall be placed on, but not fastened to, the platform. With the specimen in one position, vibrate the platform at 1/2-inch amplitude (1-inch double amplitude) starting at a frequency of about 3 cycles-per-second. Steadily increase the frequency until the package leaves the platform. The resonant frequency is achieved when a 1/16-inch-thick feeler gage may be momentarily slid freely between every point on the specimen in contact with the platform at some instance during the cycle, or a platform acceleration achieves 1 ± 0.1G. Midway into the testing period, the specimen shall be rotated 90 degrees and the test continued for the duration. Unless failure occurs, the total time of vibration shall be two hours when the specimen is tested in one position. When the specimen is tested in more than one position, the total time shall be three hours.

3. EDGEWISE ROTATIONAL DROP TEST. This test shall be conducted by using the procedures of Method 5008, Federal Standard 101. The procedure for the Edgewise Rotational Drop Test is as follows: The specimen shall be placed on its skids with one end of the pallet supported on a beam 4-1/2 inches high. The height of the beam shall be increased, if necessary, to ensure that there will be no support for the skids between the ends of the pallet when dropping takes place, but should not be high enough to cause the pallet to slide on the supports when the dropped end is raised for the drops. The unsupported end of the pallet shall then be raised and allowed to fall freely to the concrete, pavement, or similar underlying surface from a prescribed height. Unless otherwise specified, the height of drop for level A protection shall conform to the following tabulation.

GROSS WEIGHT NOT EXCEEDING	DIMENSIONS ON ANY EDGE NOT EXCEEDING	HEIGHT OF DROP LEVEL A PROTECTION
Pounds	Inches	Inches
600	72	36
3,000	no limit	24
no limit	no limit	12

4. INCLINE-IMPACT TEST. This test shall be conducted by using the procedure of Method 5023, Incline-Impact Test of Federal Standard 101. The procedure for the Incline-Impact Test is as follows: The specimen shall be placed on the carriage with the surface or edge which is to be impacted projecting at least two inches beyond the front end of the carriage. The carriage shall be brought to a predetermined position on the incline and released. If it is desired to concentrate the impact on any particular position on the container, a 4- by 4-inch timber may be attached to the bumper in the desired position before the test. No part of the timber shall be struck by the carriage. The position of the container on the carriage and the sequence in which surfaces and edges are subjected to impacts may be at the option of the testing activity and will depend upon

the objective of the tests. When the test is to determine satisfactory requirements for a container or pack, and, unless otherwise specified, the specimen shall be subjected to one impact on each surface that has each dimension less than 9.5 feet. Unless otherwise specified, the velocity at time of impact shall be 7 feet-per-second.

5. MECHANICAL HANDLING TEST. This test shall be conducted by using procedures of Method 5011, Federal Standard 101. Unit loads utilizing special design for nonstandard pallets shall be lifted, slung, lowered, and otherwise handled, as necessary, using slings of the types normally used for handling the unit loads under consideration. Slings shall be easily attached and removed. Danger of slippage or disengagement when load is suspended shall be cause for rejection of the unit load.

PART 4

TEST EQUIPMENT

1. TEST PALLET.

a. Drawing Number:	ACV00041
b. Unitization:	2-55 gallon barrels
c. Height:	49.5 inches (125.73cm)
d. Width:	24.5 inches (62.23cm)
e. Length:	41.5 inches (105.41cm)
f. Weight:	1,540 pounds (3,395kg)

2. COMPRESSION TESTER.

a. Manufacturer:	Ormond Manufacturing
b. Platform:	60 inches by 60 inches
c. Compression Limit:	50,000 pounds
d. Tension Limit:	50,000 pounds

3. TRANSPORTATION SIMULATOR.

a. Manufacturer:	Gaynes Laboratory
b. Capacity:	6,000-pound pallet
c. Displacement:	1/2-inch Amplitude
d. Speed:	50 to 400 rpm
e. Platform:	5 foot by 8 foot

4. INCLINED RAMP.

a. Manufacturer:	Conbur Incline
b. Type:	Impact Tester
c. Grade:	10 percent Incline
d. Length:	12-foot Incline

PART 5

TEST RESULTS

MIL-STD-1660 TEST

FIRST ITERATION

1. SUPERIMPOSED LOAD TEST. The test pallet was loaded to 11,200-pounds compression for a period of one hour. Periodic adjustments were made to maintain the desired stacking weight of 11,200-pounds. At the end of one hour, no noticeable deformation of the pallet or pallet assemblies was noted.

2. REPETITIVE SHOCK TEST. The test pallet successfully passed the longitudinal and lateral transportation simulations. Duration of the test was 90 minutes for each orientation of the pallet. In order to achieve the clearance between the pallet and the transportation simulator bed, the equipment was operated at 220 rpm for the longitudinal orientation and 210 rpm for the lateral orientation.

3. EDGEWISE ROTATIONAL DROP TEST. Each side of the pallet base was placed on a beam displacing it 4-1/2 inches above the floor. The ends of the pallet were raised to a height of 24 inches; and, since the pallet unit was susceptible to tipping over, the sides were only raised to a height of 15 inches. The process was repeated in a clockwise direction until all four sides of the pallet had been tested. No noticeable deformation was noted to the pallet or pallet assemblies during this test.

4. INCLINE-IMPACT TEST. The inclined plane was set to allow the pallet to travel eight feet prior to impacting a stationary wall. The pallet was rotated clockwise after each impact, until all

four sides had been tested. No deformation was noted to the pallet, or pallet assemblies during this test.

5. MECHANICAL HANDLING TEST. The sling test consisted of four different lifting configurations using the top pallet assembly and a four-legged sling. The sling configurations included a three corner, two alternate corners, two adjacent corners, and a single corner lift. No deformation to the pallet or pallet assemblies was noted during this test.

6. END OF TEST INSPECTION. During final inspection of the pallet and pallet assemblies, no noticeable deformation to the pallet or pallet assemblies was noted.

MIL-STD-1660 TEST

SECOND ITERATION

1. SUPERIMPOSED LOAD TEST. The test pallet was loaded to 11,200-pounds compression for a period of one hour. Periodic adjustments were made to maintain the desired stacking weight of 11,200-pounds. At the end of one hour, no noticeable deformation of the pallet or pallet assemblies was noted.

2. REPETITIVE SHOCK TEST. The test pallet successfully passed the longitudinal and lateral transportation simulations. Duration of the test was 90 minutes for each orientation of the pallet. In order to achieve the clearance between the pallet and the transportation simulator bed, the equipment was operated at 180 rpm for the longitudinal orientation and 190 rpm for the lateral orientation.

3. EDGEWISE ROTATIONAL DROP TEST. Each side of the pallet base was placed on a beam displacing it 4-1/2 inches above the floor. The ends of the pallet were raised to a height of 24 inches; and, since the pallet unit was susceptible to tipping over, the sides were only raised to a height of 15 inches. The process was repeated in a clockwise direction until all four sides of the pallet had been tested. The first drop was perpendicular to the skids. After the first drop, there was no noticeable deformation to the pallet or pallet assemblies. The second drop was parallel to the skids. After this drop, the pallet unit tipped forward causing a minimal amount of water to spill from one of the barrels. The top pallet adapter was deformed on the side which contacted the floor as a result of the pallet unit tipping over. The third drop showed no noticeable deformation to the pallet, or to the pallet assemblies. The fourth drop also showed no noticeable deformation to the pallet or pallet assemblies.

4. INCLINE-IMPACT TEST. The incline plane was set to allow the pallet to travel eight feet prior to impacting a stationary wall. The pallet was rotated clockwise after each impact, until all four sides had been tested. No deformation was noted to the pallet or pallet assemblies during this test.

5. MECHANICAL HANDLING TEST. The sling test consisted of four different lifting configurations using the top pallet assembly and a four-legged sling. The sling configurations include a three corner, two alternate corners, two adjacent corners, and a single corner lift. No deformation to the pallet or pallet assemblies was noted during this test.

6. END OF TEST INSPECTION. Due to the pallet unit tipping over during the drop test, the top pallet adapter was deformed on the side which contacted the floor. There was no other noticeable deformation to the pallet or pallet assemblies.

MIL-STD-1660 TEST

THIRD ITERATION

1. SUPERIMPOSED LOAD TEST. The test pallet was loaded to 11,200-pounds compression for a period of one hour. Periodic adjustments were made to maintain the desired stacking weight of 11,200-pounds. At the end of one hour, no noticeable deformation of the pallet or pallet assemblies was noted.

2. REPETITIVE SHOCK TEST. The test pallet successfully passed the longitudinal and lateral transportation simulations. Duration of the test was 90 minutes for each orientation of the pallet. In order to achieve the clearance between the pallet and the transportation simulator bed, the equipment was operated at 220 rpm for the longitudinal orientation and 175 rpm for the lateral orientation.

3. EDGEWISE ROTATIONAL DROP TEST. Each side of the pallet base was placed on a beam displacing it 4-1/2 inches above the floor. The ends of the pallet were raised to a height of 24 inches; and, since the pallet unit was susceptible to tipping over, the sides were only raised to a height of 15 inches. The process was repeated in a clockwise direction until all four sides of the pallet had been tested. No noticeable deformation was noted to the pallet or pallet assemblies during this test.

4. INCLINE-IMPACT TEST. The incline plane was set to allow the pallet to travel eight feet prior to impacting a stationary wall. The pallet was rotated clockwise after each impact, until all four sides had been tested. No deformation was noted to the pallet or pallet assemblies during this test.

5. MECHANICAL HANDLING TEST. The sling test consisted of four different lifting configurations using the top pallet assembly and a four-legged sling. The sling configurations

included a three corner, two alternate corners, two adjacent corners, and a single corner lift. No deformation to the pallet or pallet assemblies was noted during this test.

6. END OF TEST INSPECTION. During final inspection of the pallet and pallet assemblies, no noticeable deformation to the pallet or pallet assemblies was noted.

ENGINEERING PALLET TESTS

After MIL-STD-1660 tests were completed, drop tests were conducted to determine integrity of the enclosure. The "45 Degree Drum Chime Test" involved dropping a 55-gallon drum from a height of 48 inches, and maintaining a 45-degree angle from ground level to the drum chime (see drawing number 1). Tests were conducted on drums weighing 675 pounds, 560 pounds, and 475 pounds. One drop test was done for each weight (see drawing number 2). The 675-pound drum leaked a large amount of water after impact. The 560-pound drum leaked a minimal amount of water after impact. The 475-pound drum leaked a minimal amount of water after impact.

ENGINEERING PACKAGE TESTS.

A 7-foot vertical drop test was conducted on the skids which resulted in no excessive damage (see photos); also, a Tip-Over Test was conducted in accordance with Method 5018, Federal Standard 101. This was done by tipping the TEXS pallet onto its side. Both sides were tested, and there was no noticeable deformation to the pallet or pallet assemblies during this test.

PART 6

CONCLUSIONS AND RECOMMENDATIONS

1. CONCLUSIONS. The top and bottom adapter assembly passed MIL-STD-1660, Design Criteria for Ammunition Unit Loads. The second iteration of MIL-STD-1660 failed due to leakage from one of the drums, although the TEXS passed two of the three tests. The leakage could have been attributed to a loose container lid. The pallet unit is susceptible to tipping over, and the lifting rings do not allow the four-legged sling to close properly. The following recommendations would reduce the chances of this happening on production pallets.

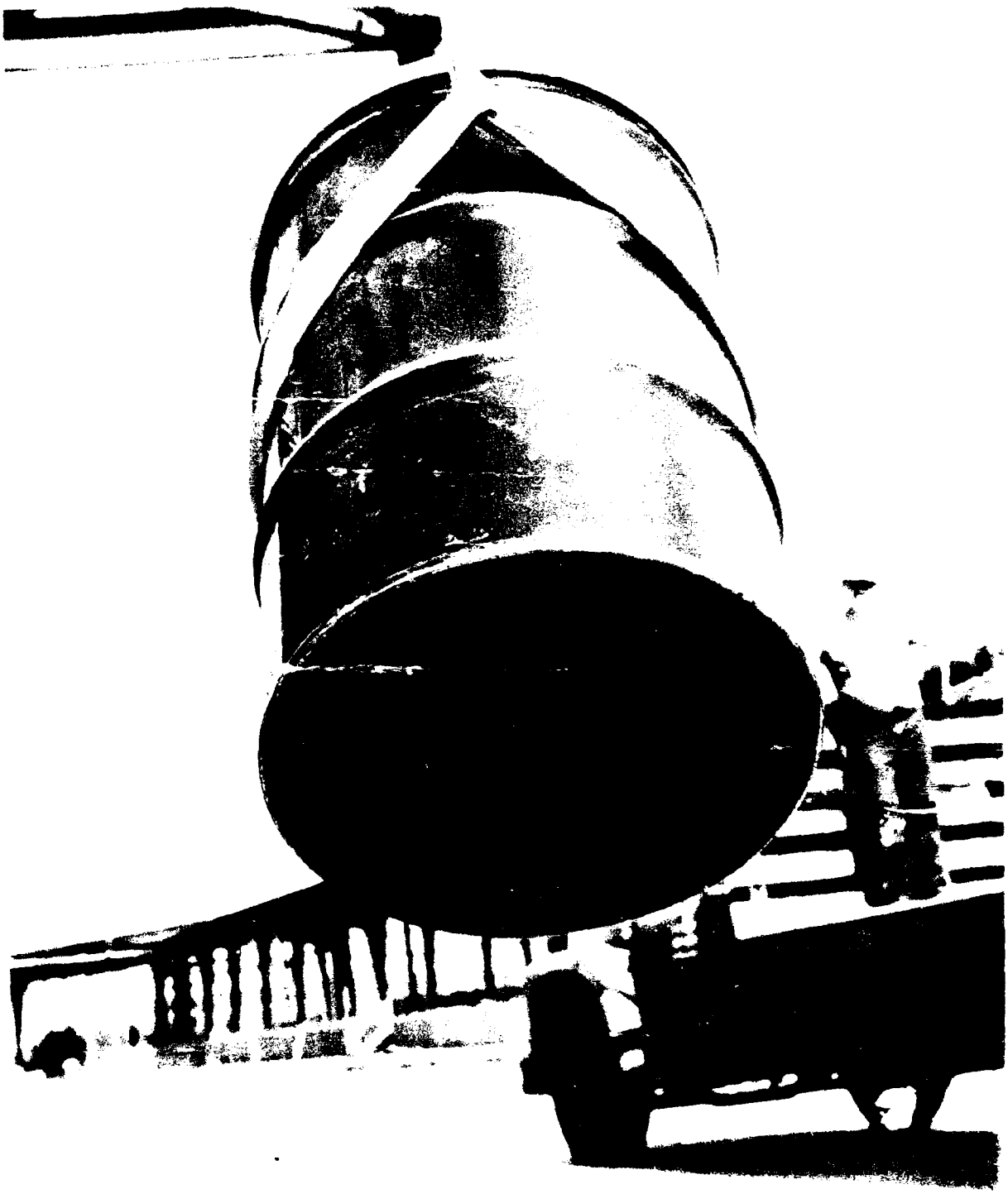
2. RECOMMENDATIONS:

a. To reduce the chances of tipping of the TEXS pallet it would be advantageous to increase the width of the pallet base to approximately 34 1/4-inches to allow the pallet to tilt 34 degrees, the approximate angle for the edge wise drop test, before tipping over. Another possibility would be to change the unitization to four barrels per pallet.

b. Since the lifting rings allow the sling to slip, the channel in the top lift adapter should be closed off to keep the sling hooks from sliding into the channel.

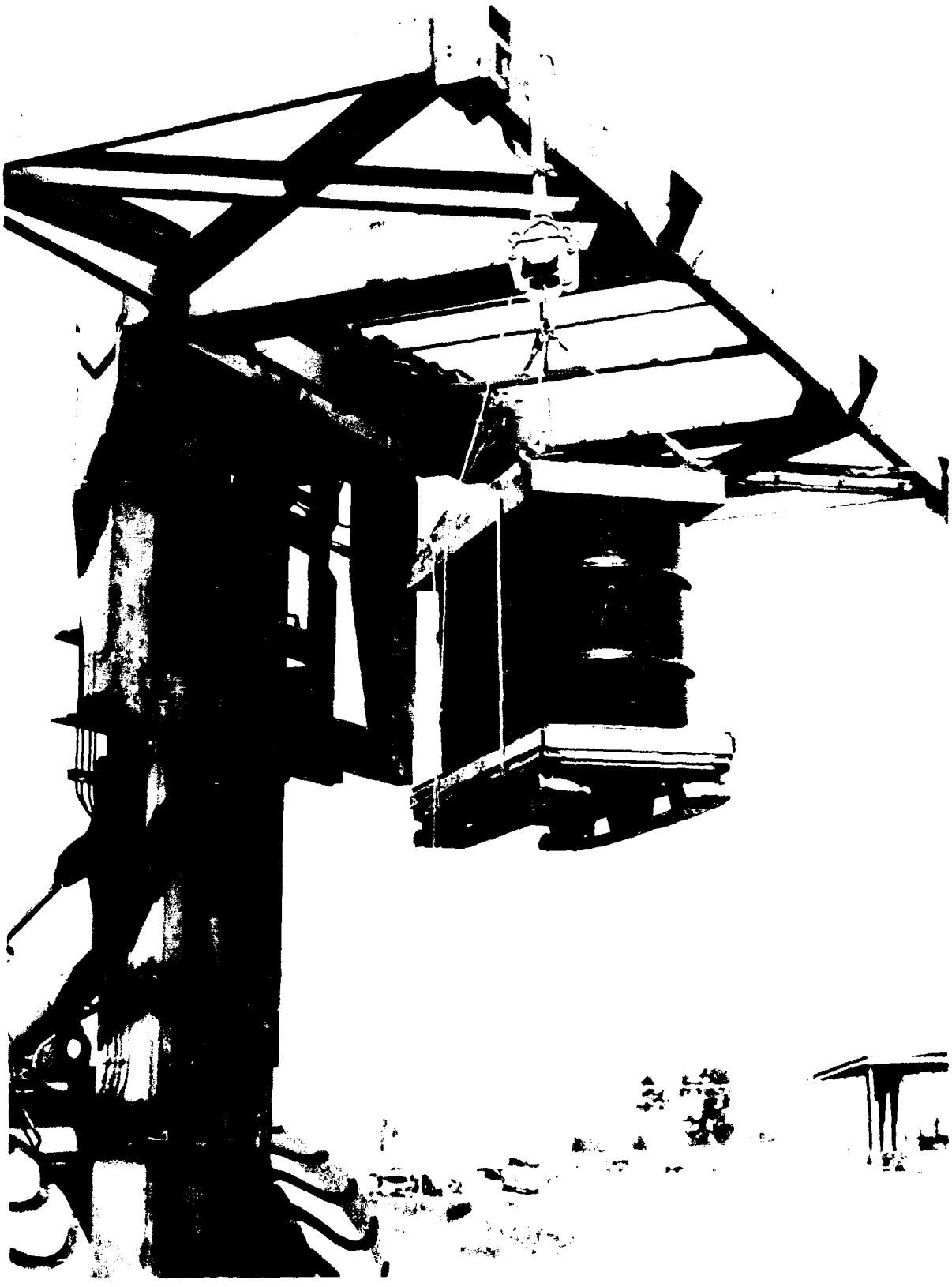
PART 7

PHOTOGRAPHS



	U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL	
Photo No. AO317-SPN-90-340-3995. This photo shows the orientation of the drum during the engineering "45 Degree Drum Chime Test."		

	U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL	
Photo No. AO317-SPN-90-340-3985. This photo shows the orientation of the TEXS pallet for the engineering 7-foot vertical drop test.		



	U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL	
Photo No. AO317-SPN-90-340-3982. This photo shows the orientation of the TEXS pallet for the engineering 7-foot vertical drop test.		

	U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL	
Photo No. AO317-SPN-90-340-3986. This photo shows the orientation of the TEXS pallet for the engineering 7-foot vertical drop test.		

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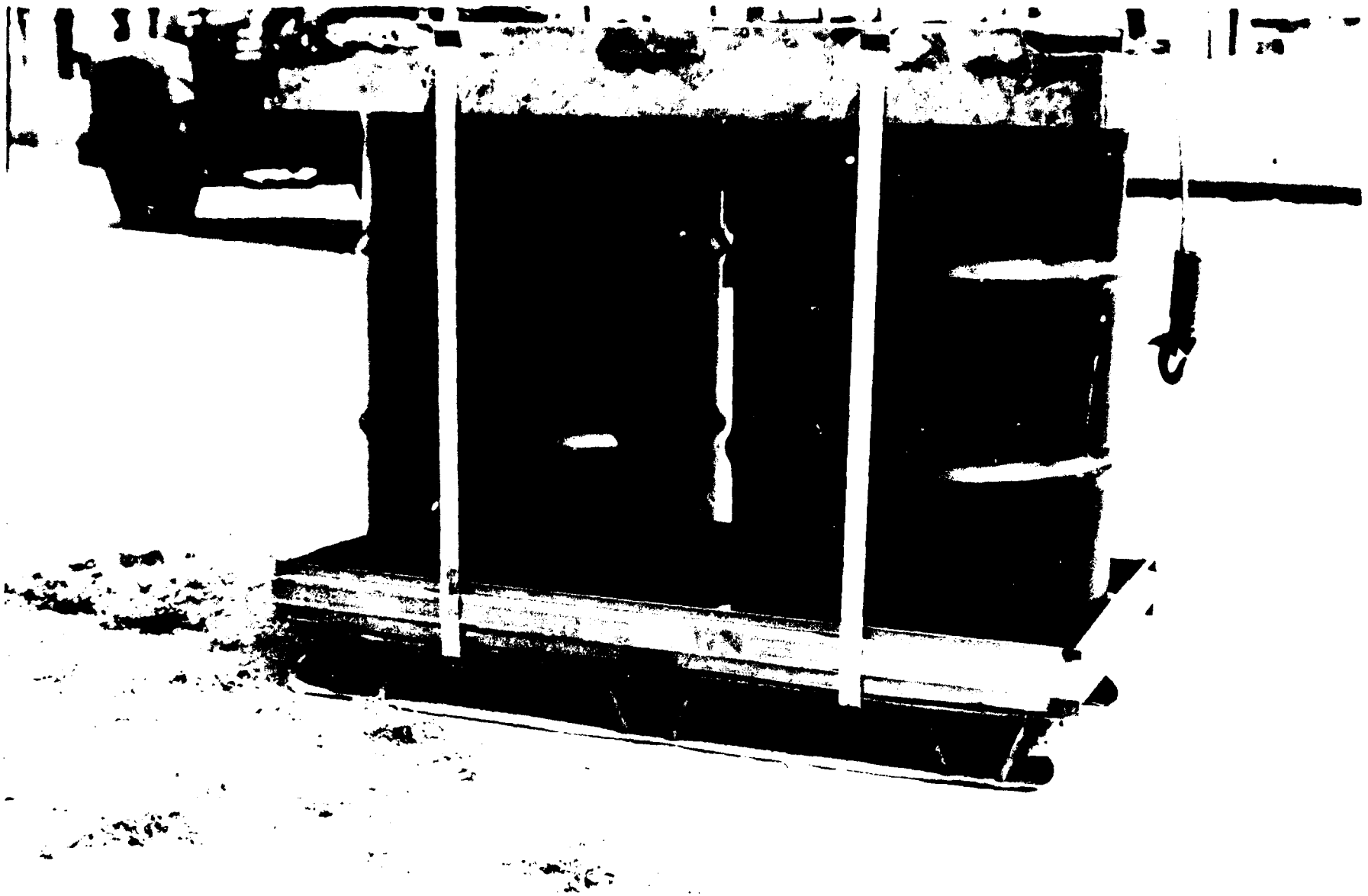
Photo No. AO317-SPN-90-340-3987. This photo shows the orientation of the TEXS pallet for the engineering 7-foot vertical drop test.

	U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL	
Photo No. AO317-SPN-90-340-3988. This photo shows the orientation of the TEXS pallet for the engineering 7-foot vertical drop test.		



	U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL	
Photo No. AO317-SPN-90-340-3989. This photo shows the orientation of the TEXS pallet for the engineering 7-foot vertical drop test.		

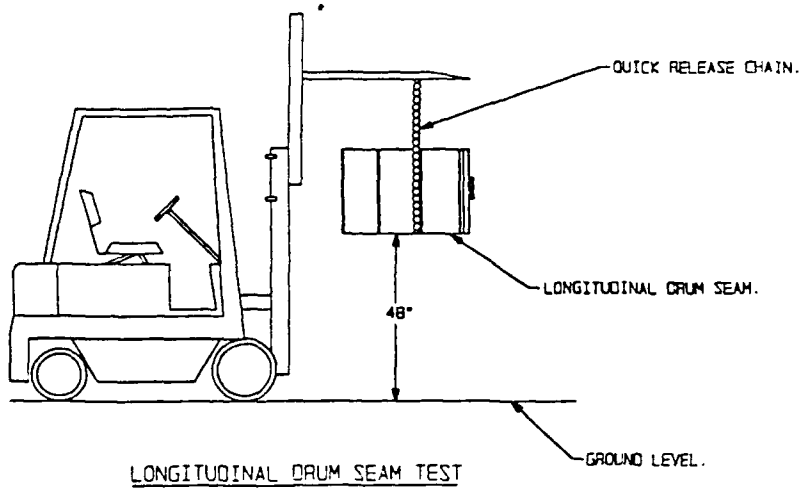
	U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL	
Photo No. AO317-SPN-90-340-3997. This photo shows the damage to the pallet adapter for the engineering 7-foot vertical drop test		

	U.S. ARMY DEFENSE AMMUNITION CENTER AND SCHOOL - SAVANNA, IL	
Photo No. AO317-SPN-90-340-3998. This photo shows the damage to the pallet adapter from the engineering 7-foot vertical drop test..		

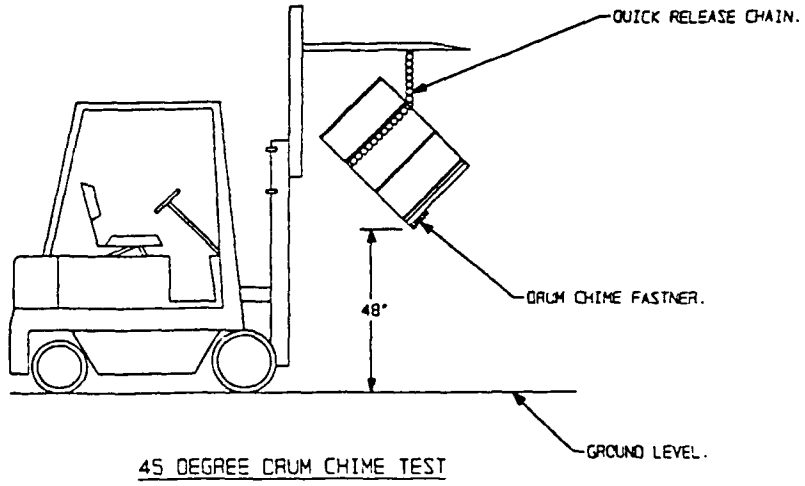
PART 8

DRAWINGS

ENGINEERING DROP TESTS



LONGITUDINAL DRUM SEAM TEST

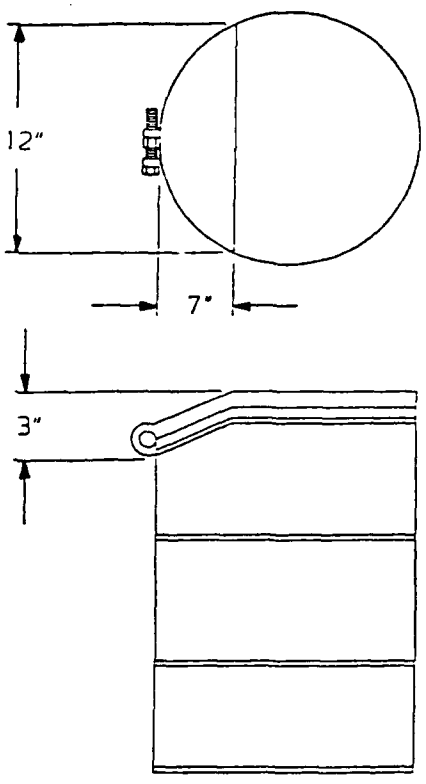


45 DEGREE DRUM CHIME TEST

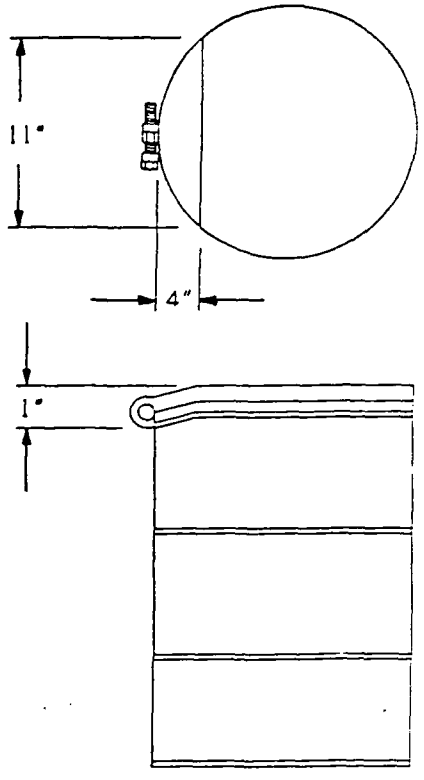
NOTES:

1. ONE DROP TEST PER CONTAINER.
2. THREE TESTS FOR BOTH THE LONGITUDINAL DRUM SEAM, AND FOR THE 45 DEGREE DRUM CHIME FASTNER.

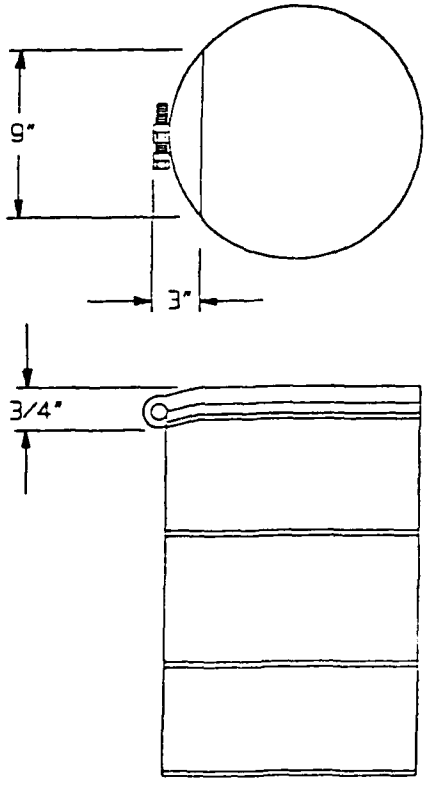
DROP TEST DAMAGE



675 LBS



560 LBS



475 LBS

NOTES:

1. DEFORMATION OF 55-GALLON DRUMS DROPPED A HEIGHT OF 48".